Asymmetric Magnetic Disorder Observed in Thermally Activated Magnetization Reversal of Exchange-Biased IrMn/CoFe Films

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The ferromagnet (F) in contact with an antiferromagnet (AF) shows the enhancement of coercive field and loop shift from the origin when the AF/F bilayer system is cooled down through the Neel temperature of AF, known as the exchange-bias effect [1]. One of the most interesting and unsolved issues in this field is elucidating the physical origin of asymmetric magnetization reversal behavior in the exchange-biased F layer [2]. In this work, we show that asymmetry of magnetic disorder the major origin of asymmetric magnetization reversal behavior in exchange-biased IrMn (t_{IrMn}=5-20 nm)/CoFe (50 nm) films using a Kerr microscope, capable of direction observation. From the correlation between the magnetization half-reversal time and applied magnetic field, we find that the magnetization switching in all the films occurs via a thermally activated reversal mechanism for both branches of hysteresis loops. From the domain reversal patterns, it was found that magnetization reversal behavior is quite different between both branches of a hysteresis loop even though all measurements were carried out at exactly the same observation area. Surprisingly, in the forward branch reversal where the applied magnetic field is antiparallel to the direction of exchange-bias field, a degree of magnetic disorder decreases as exchange-bias field increases, which is definitely contrasted with the case of backward branch reversal. This indicates that a degree of magnetic disorder is quite different even though the structural disorder is identical. This result is likely ascribed to the fact that the local values of exchange-bias field and coercive field are oppositely fluctuated with each other in the film.

References

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